APPENDIX G

WATER USAGE IN DESERT OPERATIONS

Combat operations in the desert pose a number of unique problems. Because there is so little water and because our troops and much of our equipment cannot survive without it, water is a critical item of supply in the desert. Forces trying to survive in the desert without adequate water supplies have always met with disaster. Finding and keeping water sources may be the most crucial issue in desert conflicts. At the very least, water sources will be critical.

PROPER USES OF WATER

Water must be used to support immediate and future missions. There will be times when there is enough water to fill all requirements, but there will also be times when command direction and considerable thought are necessary to decide how to make the best use of available water. The first priority must go to the survival of the force and accomplishment of the immediate mission, and second priority to the maintenance and sustainment of the force. A general priority for uses of water is-

- Personnel (drinking only).
- Medical treatment.
- Vehicle and equipment cooling systems.
- Personnel (uses other than drinking).
- Decontamination.
- Food preparation.
- Laundry.
- Construction.

How far the available water will stretch depends upon your evaluation of the local situation and mission; how you set priorities for water; and how careful you are in using your limited supply.

INTEGRATED BATTLEFIELD EFFECTS ON WATER USE

Water needs increase dramatically on a nuclear or chemical battlefield. Decontamination of men and equipment requires large quantities of water. Being

"buttoned up" in vehicles or in NBC protective gear locks in heat and perspiration and makes men sweat more. This increases the need for drinking water to avoid dehydration and heat casualties. Replacement of fluids lost through sweat is a critical use of water and generally comes ahead of all other uses.

LEADER RESPONSIBILITIES

Your primary responsibility is to accomplish your mission. Water is essential to do that. You must estimate how much you need and when you need it, just as you do for any type of essential supply. When the supply is limited, you must adjust your plans. During the accomplishment of your mission you must monitor the supply and ensure that it is used according to your plan.

One of the biggest water-related problems you may face is that as troops recognize how valuable water is to their survival, they may hoard it and not drink enough to sustain the efforts you expect of them. Before periods of activity, have your troops drink as much as they can. During the activity, take positive steps to make soldiers/marines replace the water lost by sweating. Thirst is a poor indicator of the body's need for water and maybe ignored during hard work or in the heat of battle. Squad and section leaders must make their men drink regularly.

EFFECTS OF HEAT AND LACK OF WATER

Objects absorb heat from the sun and the air. In the desert, heat from these two sources is extreme. The clear, low-humidity air lets most of the heat from the sun through. As the sunlight strikes an object, such as a soldier/marine or the ground, much of the heat is absorbed. The ground, heated by the sun, in turn heats the air, often to temperatures well over 100 degrees Fahrenheit. A man, or any other object in the sun, absorbs heat from both sources. A man in the shade only has to contend with the heat from the air. The third major source of heat is the body itself. Like an engine, the body generates excess heat as it functions. The more work performed, the more heat that is generated. There are four ways that heat leaves an object:

- Radiation heat radiates from an object to a cooler object through a medium.
- Conduction heat flows from a hot object to a cooler object through direct contact.
- Convection heat flows from a hot object into a cooler surrounding medium like air.
- Evaporation heat is absorbed in changing a liquid (like water) into a vapor.

The heat losses from radiation and conduction are relatively small for people and equipment. If the air is much cooler than the surface of an object, such as a vehicle radiator or a person's skin, convection can remove significant amounts of heat. As the two temperatures get closer, this loss becomes smaller. If the air is hotter than the object, as is often the case in the desert, heat is gained from the air. In hot, dry desert climates, the primary method of losing excess heat from the body is the evaporation of sweat. The rate of sweating depends on the amount of excess heat the body needs to lose. Hard work in hot climates can result in 1-1/2 to 2-1/2 quarts of sweat lost per hour.

Supporting medical units measure the combined effects of the sun, air temperature, and humidity on dismounted troops in open terrain. This combined effect, measured as the Wet Bulb Globe Temperature (WBGT) or the Wet Globe Temperature (WGT), is translated by the supporting medical unit to a heat condition.

Men cannot be expected to routinely perform more than about 5 hours of heavy work per day in heat condition BLACK. However, using a 20-minute work/40-minute rest cycle, it will take 15 hours to do 5 hours of work. Similarly, in heat condition RED, a maximum of 6 hours of heavy work can be expected; in heat condition YELLOW, 7 hours; and in heat condition GREEN, 8 hours.

The heat condition experienced by individual soldiers/marines may differ from the general heat conditions in the area. The activity level in closed vehicles (such as tanks and armored personnel carriers) will probably be less than that of troops outside, but the air temperature may be 20 to 30 degrees Fahrenheit higher, thus increasing the soldier's heat gain from the air and, as a result, his sweat rate and need to drink water. As a general rule, increase the water intake to that for two or three heat conditions higher for troops in enclosed vehicles. On the other hand, troops performing light duty in the shade are not as severely stressed and will need less water and less rest time.

In practice, keeping track of the current heat condition and applying it to troops working in a wide variety of conditions will be difficult, if not impossible. This data gives you an understanding of how much water is required by troops when they work hard in the desert heat and to point out the limits of an individual's efforts in extreme heat. Work done in the heat of the day takes much longer and is more fatiguing than work done under relatively cooler conditions. Work schedules planned to take advantage of the cooler times of day-early morning, late evening, and night—not only increase productivity and reduce water use, but they are akso easier on the men and better for their morale.

EFFECTS OF WATER LOSS

The body has a small reserve of water and can lose some without any effects. After a loss of about 2 quarts (which represents about 2.5 to 3.0 percent of body weight), effectiveness is impaired. Soldiers/marines may begin to stumble,

become fatigued and unable to concentrate clearly, and develop headaches. Thirst will be present but not overpowering. So unless well trained, or reminded or goaded to drink, troops may not replace the water loss.

As dehydration continues, the effects will become more pronounced. The soldier/marine will become less and less effective and more likely to become a heat casualty. Some soldiers/marines will experience heat cramps, others will develop heat exhaustion or heatstroke. Heat cramps and heat exhaustion can be treated with good success and the soldier/marine returned to duty in a few days; however, without prompt medical attention, heatstroke can be fatal. Even if the man survives, he will probably not be returned to duty. In any case, a heat casualty is lost for some time. Preventing casualties is much easier than treating and replacing the casualties.

WATER SUPPLY PLANNING

Water planning is complicated because water is heavy (about 8.3 pounds per gallon) and may be considered perishable. Water stored in small containers gets hotter than water stored in large containers. As water gets hotter, it loses its disinfectant and becomes less desirable to drink. These facts make it difficult to carry an adequate supply of water, and frequent resupply is often required. The following questions must be answered when planning the unit's water supply:

- How much water is needed?
- Where is it needed?
- When is it needed?
- How will water get to the unit?
- How does water supply affect the mission?
- How does the mission affect water requirements?
- What measures need to be taken to ensure water is properly used?

There are several requirements for water. Some requirements, such as water for radiators, are reasonably constant. Some, such as water for food preparation or showers, are prescribed by the situation. Others, such as water for drinking and personal hygiene, depend on how the mission is accomplished. Planning water requirements for centralized service support functions (shower, laundry, medical treatment, maintenance, and construction) is the responsibility of the supporting organization. The largest and most critical planning factor is drinking water. The quantity required depends on the environment and the difficulty and intensity of individual activity.

When calculating water requirements for a whole day, you need to consider other requirements, such as shaving, brushing teeth, and helmet baths. On the average, these functions require almost 2 gallons of water per man per day. When B rations are issued, plan for 1 gallon of water per meal for the mess kit laundry,

and 0.5 gallon per meal for food preparation and kitchen cleanup if the unit prepares its own B rations. The water used to heat individual combat rations can be reused for washing and shaving.

When calculating water requirements for individual details, plan to use 2 quarts of water per hour of hard work per man (including rest periods) during the heat of the day, or 1 quart of water per hour of hard work per man in the cooler parts of the day. These quantities are intended to satisfy requirements for drinking water as well as for the water that men will pour over their heads when they are hot. Experience with local conditions and the work performed may change these estimates. It is important to remember that water lost by sweating will be replaced sometime during the day, but men work best if the water is replaced as it is lost.

WATER REQUIREMENTS

Some examples of water planning calculations are provided in the following paragraphs.

Example 1. A 10-man squad performing heavy work that will take about 2 hours at a Continental United States (CONUS) base.

If the squad works in the late morning, with a 30-minute work, 30-minute rest cycle (heat condition RED), the work will take almost 4 hours. At 2 quarts of water per man per hour, the squad will require 20 galIons of water or 8 quarts (2 gallons) per man.

If the squad works at night or in the very early morning (heat condition GREEN or cooler), with a 50-minute work, 10-rninute rest cycle, the work will take about 2 hours. At 1 quart of water per man per hour, the squad will require 5 gallons of water or 2 quarts (0.5 gallon) per man.

Example 2. A 40-man platoon doing a variety of work over an entire day.

The platoon requires 4 gallons of water per man per day for drinking, and 2.5 gallons per man per day for personal hygiene, or 6.5 gallons per man per day. For the whole platoon, 260 gallons (6.5 x 40) per day are required. (Meals not considered.)

Example 3. A 160-man company doing a variety of work and eating two B. ration meals and one MRE or MCI ration per day delivered from the battalion consolidated kitchen.

The company requires 4 gallons of water per man per day for drinking, 2.5 gallons per man per day for personal hygiene, and 1 gallon per meal for the mess kit laundry.

6.5 gallons (4 + 2.5) per man per day x 160 men	=	1,040 gallons
+ 1 gallon per B-ration meal x 320 rations*	=	320 gallons
Total		1,360 gallons per day

*Not required if an expedient means can be used to avoid having to wash plates and utensils.

NOTE: If company personnel operate their own field kitchen, 0.5 gallon per B-ration meal is required. In this example, an additional 160 gallons (0.5 x 320) would be needed.

Example 4. A 750-man battalion performing a variety of tasks, operating a battalion field kitchen, and feeding two B-ration meals and one MRE or MCI per day.

The battalion requires 6.5 gallons of water per man per day for drinking and personal hygiene, and 1.5 gallons per B-ration meal served.

6.5 gallons per man per day x 750	=	4,875 gallons
+ 1.5 gallons per B-ration meal x 1,500	=	2,250 gallons
Total		7,125 gallons per day

The situation will usually dictate whether an element will pick up its own water or have it delivered to it. Normally, water is either produced at or delivered to a water supply point in the brigade rear. Forward units pick up their water at the water supply point and move it forward using organic transportation. Water distribution is normally planned and coordinated at company or battalion level.

Long distances and increased consumption compound water transportation problems in the desert. Several specialized pieces of equipment are available to overcome these problems. They have been designed and allocated to permit units to move and store the larger than normal volumes of water required in the desert. They are also capable of delivery by ground and air transportation, airdrop, or low altitude parachute extraction system (LAPES). Air transportation, while possible, is usually limited by aircraft availability and weight of water required. It is normally used only when ground transportation is not feasible.
Water shortages can severely limit your unit's mission capabilities. If you cut water use to absolutely essential requirements, you can temporarily overcome limited water shortages, but severe shortages will limit your unit's mobility and capability. Water shortages may make some daylight operations or hard work infeasible or unsupportable. Each course of action must be analyzed with respect

to water support requirements and the capacity of troops to sustain their efforts under severe heat conditions. Water supplies are equally important to the enemy. Taking and keeping water sources, or denying or destroying enemy water supplies can critically alter the options available to the enemy.

You and your unit can do several things to use water to your advantage. First, make sure that enough water is available for the most critical use-drinking. Furthermore, water must be available right where it is needed. Troops working in the desert should not have to walk more than a short distance to a water source. During rest periods some soldiers/marines would rather sit than walk to get water, especially if they are not thirsty. It must be easy for them to get water. Similarly, beverages must be readily available in dining facilities. There should be enough beverage dispensers that troops do not have to wait long in lines.

In addition to having water readily available, you must also make sure that soldiers/marines actually drink all the water they need. Since the signs of dehydration are not obvious until a person is close to heat injury, leaders at the squad and platoon level must keep track of water consumed and take the following measures:

- Have troops drink an extra quart of water before hard work. Storing water in your stomach gives you an extra quart of reserve capacity.
- Keep track of how much water each man drinks at the squad level; at the platoon level, monitor the use rate at each squad.
- Have troops take breaks as often as the heat condition requires, and during breaks remind or require the troops to drink.
- Make sure water is kept as cool as possible so it will be as palatable as possible to drink,
- Watch the troops for the first signs of heat stress and reduced effectiveness, such as stumbling and slurred speech.
- Have your soldiers/marines check their urine. A lack of the need to urinate and dark-colored urine are signs of dehydration.
- Use the buddy system within the squad to help ensure soldiers/marines are drinking enough.
- Make sure troops wear their uniform correctly. Shirts should be on with sleeves rolled down, scarf around neck, and hat on. The uniform should be worn as loosely as possible.

In order for water to be useful for its most critical purpose in the desert, it must be protected not only from enemy action but also from heat and contamination. The larger quantities of water required for drinking in the desert increase the importance of the quality of the water. Water can carry minerals, microbiological organisms, and toxic materials. The body can handle only so much of these contaminants before its natural defense mechanisms become swamped and health and effectiveness deteriorate.

When water has been treated and distributed to water points, it has already been checked for contamination by water purification unit operators and medics; however, these checks do not ensure the water will not become contaminated somewhere in the unit distribution system before a soldier/marine drinks it.

When water is purified and distributed, it is usually disinfected by adding chlorine to a level prescribed by the Command Surgeon. The chlorine not only kills the microbiological organisms presently in the water, but some also remains in the water to kill any bacteria that might get into the water later. Such contamination can be minimized by using common sense at the unit level. Store water only in clean containers intended for water, and do not let anything get in the water that you would not want to drink.

However, even if your unit is very careful, water may eventually become contaminated. As the water is handled or gets hot, the chlorine's disinfecting power disappears. Your company's field sanitation team measures chlorine levels in unit water containers. The team also has ampules of a chlorine compound that are used to replace chlorine in small containers. Each soldier/marine is issued a small bottle of iodine tablets to disinfect water in his canteen if he must take water from an expedient, untreated source.

Heat is another contaminant of water in the desert. When water is warmer than 75 or 80 degrees Fahrenheit, it becomes difficult to drink. Bad tastes in water become more pronounced as water becomes wanner and people will not want to drink it. Small-unit leaders will have a very difficult task trying to get troops to drink all the water they need to replace losses if the water tastes bad. Water tastes best, and it is easier to drink large quantities of it, if it is between 50 and 70 degrees Fahrenheit. There are three ways to avoid the problems of drinking hot water:

- Drink it before it gets hot.
- Keep it in a cool place or in the shade.
- Cool it to a palatable temperature.

Drinking water before a period of heavy work or before leaving the unit area on a mission gets valuable water into the body before the water has a chance to heat up. It also provides an additional reserve of water that is easy to carry.

Water in containers absorbs heat from three sources-the air, the ground, and sunlight. There is no easy way to cut absorption from the air, but you can reduce heat absorbed from the ground and sun by keeping containers in as much shade as possible. There are certainly many ways of getting shade for water containers; with a little American ingenuity and available materials, it can be done.

Small, uninsulated water containers heat up more quickly than larger or insulated containers. Fortunately, the water in small containers can be used more quickly before it heats up. Water in uninsulated 5-gallon cans starting at a cool 60

degrees Fahrenheit can heat up to unpalatable temperatures in three to four hours on a hot (greater than 90 degrees Fahrenheit) day in the full sun, but it will take seven to eight hours if kept in the shade. Unshaded 55-gallon drums will heat to unpalatable temperatures in about one day of full sun, but will stay drinkable for two days if shaded. Insulated 400-gallon water trailers in or out of the sun will keep water cool for several days.

Water must be cool to start with if it is to be kept cool. One of the supplemental items available to company-size units is a small mobile water chiller. The chiller is designed to provide cool (about 60 degrees Fahrenheit), palatable water for company-size units. It can be used to cool and dispense water from any container into canteens, water cans, or any other container at a rate of at least 0.5 gallon per minute. It should be used in all cases where individuals must be encouraged to drink large quantities of water, and to cool water being taken with or to elements working away from the company area.

SURVIVAL TECHNIQUES

The water support logistics structure is designed to provide enough water to retain maximum force effectiveness, especially on a battlefield. It would be foolish to expect that the large quantities of water required for a combat force will always be available. Water is a critical supply in desert combat. Having less than full supply for all needs does not necessarily spell disaster for operations, but it may force changes in plans. There are several options available to you if you are forced to operate on reduced water supplies. The first part of this chapter outlines those options. The second part (described in the following paragraphs) describes actions and techniques for small groups or individuals to take when totally cut off from normal water supply.

The first and most obvious option is to eliminate, reduce, or postpone water uses not immediately required for survival or mission accomplishment. Showers, laundry, personal hygiene, and B-rations can usually be eliminated for several weeks without severe impact on troop health or combat effectiveness, although this tactic will eventually reduce troop health and morale. Also, construction requiring water can often be avoided.

The one water use that cannot be denied without significant risk is individual drinking. However, significant reductions in individual drinking requirements are possible by—

- Limiting all but absolutely essential work to the cooler parts of the day (early morning, late evening, and night).
- Keeping individuals in the shade as much as possible.
- Severely limiting al1 activity.

All of these actions reduce the effectiveness or capability of a force, but they help it to survive.

What can individuals or small groups do when they are totally cut off from normal water supply? If you are totally cut off from the normal water supply, the first question you must consider is whether you should try to walk to safety or stay put and hope for rescue. Walking requires 1 gallon of water for every 20 miles covered at night, and 2 gallons for every 20 miles covered during the day. Without any water and walking only at night, you may be able to cover 20 to 25 miles before you collapse. If your chance of being rescued is not increased by walking 20 miles, you may be better off staying put and surviving one to three days longer. If you do not know where you are going, do not try to walk with a limited supply of water.

If you decide to walk to safety, follow the following guidelines in addition to the general conservation practices listed in the next section:

- Take as much water as you have and can carry, and carry little or no food.
- Drink as much as you can comfortably hold before you set out.
- Walk only at night.

Whether you decide to walk or not, you should follow the principles listed below to conserve water in emergency situations:

- Avoid the sun. Stay in shade as much as possible. If you are walking, rest in shade during the day. This may require some ingenuity. You may want to use standard or improvised tents, lie under vehicles, or dig holes in the ground.
- Cease activity. Do not perform any work that you do not have to for survival.
- Remain clothed. It will reduce the water lost to evaporation.
- Shield yourself from excessive winds. Winds, though they feel good also increase the evaporation rate.
- Drink any potable water you have as you feel the urge. Saving it will not reduce your body's need for it or the rate at which you use it.
- Do not drink contaminated water from such sources as car radiators or urine. It will actually require more water to remove the waste material. Instead, in emergencies, use such water to soak your clothing as this reduces sweating.
- Do not eat unless you have plenty of water.

Do not count on finding water if you are stranded in the desert. Still, in certain cases, some water can be found. It does rain sometimes in the desert (although it may be 20 years between showers) and some water will remain under the surface. Signs of possible water are green plants or dry lake beds. Sometimes water can be obtained in these places by digging down until the soil becomes moist and then waiting for water to seep into the hole. Desert trails lead from one water point to another, but they may be further apart than you can travel without water. Almost all soils contain some moisture.